

*Jet injector immunization guns were used by the County of Los Angeles Health Department in its School Immunization Program in 1968. Considerable savings in personnel time and in vaccine costs resulted. The advantages of using the guns outweigh the associated problems.*

## **JET INJECTOR: APPRAISAL OF ITS USE IN A LOCAL SETTING**

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### **Introduction**

THE County of Los Angeles Health Department has conducted an annual School Immunization Program for several years. The major portion of expenses has been related to physician and nursing salaries. With the introduction of measles vaccine, the cost of vaccine became a significant factor in the total program budget. Cost analysis indicated that a large saving in salaries and in outlay for vaccine would accrue if jet injectors were used. The experience of the department with the jet guns is presented in this paper.

### **Methods and Materials**

The Immunization Project of the County of Los Angeles Health Department is funded with local and U. S. Public Health Service funds. In 1966-1967, the policy of the Public Health Service for community measles eradication programs was to distribute dog kidney (DK) live measles vaccine\* to a local immunization project. An equivalent amount of cash was provided when another measles vaccine was preferred. The lower incidence of clinical reac-

tions following vaccination with further attenuated (FA) live measles vaccine,† as well as the greater ease of administration, prompted the department to use the FA vaccine in its immunization program. Despite the higher cost of FA vaccine, it was estimated that the decrease in administration time resulting from giving one instead of two injections would lower staff salaries sufficiently so that the total cost of giving either vaccine would be essentially the same.<sup>1</sup>

A further reduction in program costs was envisioned by administering the FA vaccine with an electric jet gun‡ rather than with syringes. The largest portion of the saving was in the use of multidose vaccine vials. The saving incurred by reducing the time for vaccine administration was proportionally smaller but nevertheless significant. Approximately 100 injections an hour can be given by a trained person using syringes; with a jet gun, 400 injections per hour may be administered by an individual with minimal experience. An upper limit of about 1,000 injections

† Lirugen, manufactured by Pitman-Moore.

‡ Hypospray Jet Injector Gun, manufactured by R. P. Scherer Co.

NOTE: Trade names are included for identification only.

\* Manufactured by Philips-Roxane.

**Table 1—Time required for preparation and administration of a single dose of further attenuated measles vaccine—comparison of two methods**

Method	Physician time/dose +	Nurse time/dose =	Total Profes- sional staff time/dose
Syringe	36 sec	96 sec	132 sec
Gun	9 sec	3 sec	12 sec
Difference:	27 sec	93 sec	120 sec

per hour may be achieved by an experienced operator when the vaccine recipients are lined up and calm.<sup>2</sup> In addition to reducing the duration of each immunization clinic, use of the jet guns permits minimal preparation before the beginning of each clinic (Table 1). Where syringes are used, from two to four hours of a nurse's time are required to preload syringes.

The total cost of administering FA measles vaccine by syringe is \$1.66 versus \$1.13 by jet gun (Table 2). When these costs are projected for 100,000 immunizations, a saving of \$53,000 would accrue to the Health Department from using the jet gun. The cost of one gun for each of 23 health districts is approximately \$36,000.

In 1967 a mass measles immunization program was conducted by the Health Department. Over 92,000 immunizations were administered with jet injector guns borrowed from the National Communicable Disease Center, Atlanta, Georgia. The results of the program were compared with an earlier measles campaign in April, 1966, during which 87,000 children were vaccinated by syringe with FA vaccine.<sup>3</sup> The time saved in vaccine preparation and administration was easily appreciated. The jet gun was readily accepted by physicians and nurses. Moreover, training a large group of physicians and nurses to operate the guns and a small group (six) of laymen to maintain them was accomplished without undue difficulty. The successful experience in the 1967 campaign prompted the department to poll the health districts to determine who would use a jet gun and which type of gun was preferred. Sixteen selected the electric model, one district preferred the foot-operated type of jet gun, and none requested the hand-operated model. Six districts preferred not to use a gun at all. To simplify the training of maintenance personnel, it was decided to purchase only one type of gun—the electric model. One gun per district was ordered in anticipation of future needs and of additional requests

**Table 2—Cost of administration of a single dose of further attenuated measles vaccine—comparison of two methods\***

Method	Vaccine	Physician salary (\$9.50/hr) +	Nurse salary (\$3.79/hr)	Total Professional personnel = cost	Total cost
Syringe	\$1.46	\$0.10	\$0.10	\$0.20	\$1.66
Gun	1.10	0.02	<0.01	0.03	1.13
Savings with gun	\$0.36	\$0.08	\$0.09	\$0.17	\$0.53

\* Based on time per dose noted in Table 1. Figures are approximate and do not include overhead and incidental expenses because they are similar for both modes of administration.

from districts that did not show initial preference for a gun.

Three Immunization Project staff members—a physician and two project advisers—conducted several training programs to add to the broad base of experience acquired in the 1967 campaign. Physicians and nurses were given three more training sessions in jet gun operation. A new group had to be trained to make repairs, to sterilize the guns, and to apply preventive maintenance. The Communicable Disease Investigators (CDI) were chosen to do this job, since these men already worked closely with the Immunization Project and the Division of Acute Communicable Disease Control. Three intensive training sessions were conducted with the entire CDI group and one with their supervisors.

## Results

During the first month of jet gun use, three more health districts requested a gun and one large district requested a second gun. Initially, maintenance problems arose in 25 per cent of the districts using guns; three or four of these problems a week could not be corrected in the field and had to be handled by the Immunization Project staff. By the third month of the program, most maintenance problems were satisfactorily handled in the district or by the Senior Communicable Disease Investigators. Operational difficulties, unrelated to improper maintenance, did not occur as frequently—about one or two per week during the first month. Thereafter, none were called to the attention of the project staff. The main operational difficulty was caused by an incorrectly adjusted trigger spring which resulted in slow trigger return in 31 per cent of the guns; however, a visit by the company representative rectified the problem.

After two months of district experience with the jet guns, a survey was

conducted by the Immunization Project staff to review operational techniques with the district physicians and nurses responsible for the school programs. Sixteen of the 20 districts using guns had had their immunization programs under way for two months. One school clinic in each of these 16 districts was visited by a project staff member. A standard three-page survey form was completed for each clinic. School clinics that had more than 100 children scheduled for immunization were selected. Only one district did not have this large a clinic during the survey period.

Findings were grouped under ten items, which are listed in Table 3. The elements that comprise each item are discussed in order of importance:

*Item 1*—The condition of the gun in transit was considered faulty when maintenance kits did not accompany the

**Table 3—Survey of jet gun and clinic operations in school immunization clinics, County of Los Angeles, 1967**

Item	Proper procedure followed %	Improper procedure followed %
1. Condition in transit	81	19
2. Amount of vaccine reconstituted before session	75	25
3. General preparation prior to use	91	9
4. Vaccine stream checked prior to use	100	—
5. Trigger operating smoothly	62	38
6. Spool valve operating smoothly	100	—
7. Administration of vaccine	86	14
8. Maintenance checks during gun use	67	33
9. Time between children	62	38
10. Clinic flow	59	41

gun, when the oil valve was not closed, or when the pressure hose or electric cord was improperly placed. In no case was there evidence of oil leakage in the bottom of the gun case. In all instances, a vial of sterile water covered the intake needle.

*Item 2*—More vaccine vials than necessary were reconstituted before the clinic began at 25 per cent of the sites, causing waste in some clinics.

*Item 3*—The gun was properly prepared for use in most instances. In a few clinics, the gun was not inverted for vaccine vial loading, and in one clinic, the gun was not test-fired with sterile water before vaccine loading. Otherwise, the oil valve was placed in "open" position before operation, and the gun was flushed three times with vaccine before use.

*Item 4*—At every clinic, the vaccine stream was very thin as it came out of the gun nozzle, and the stream did not fan out until one or more inches beyond the nozzle.

*Item 5*—The trigger return on six guns was slow.

*Item 6*—The spool valve moved smoothly in each gun.

*Item 7*—The most common problem during the actual injection was holding the gun on the arm for less than the suggested three seconds. This occurred at four of the schools. Less frequently, the gun was not placed on the back of the arm (over the triceps muscle), was not held at a 90 degree angle to the arm (or humerus), and was not held firmly enough for the nozzle to leave an imprint on the skin. No skin lacerations at the injection site occurred at any of the clinics visited and none were reported throughout the year-long program.

*Item 8* — Preventive maintenance checks by the gun operator during gun use were carried out in most cases. The usual problem was that the nozzle was loose or the gun had not been test-fired

once or twice with vaccine after changing vaccine vials.

*Item 9*—There was excessive delay between vaccine recipients at several clinics.

*Item 10*—Clinic flow was hampered in many instances by having too few children with swabbed arms awaiting the gun operator and by having the immunization team wait more than one or two minutes before a new classroom of children arrived at the central immunization site. Occasionally, there was not enough interaction with the children to allay their anxiety about the gun. At most sites, there were enough volunteers to check the children's arms following vaccination.

There were other points, problems, or complaints which arose during the survey. Most physicians and nurses felt comfortable with the gun, its use and its quirks, after using it for one month. Nevertheless, all district personnel thought the gun and its motor were too noisy and frightened the children. Getting consent forms completed was not a problem, as most were filled out by parents in advance of the clinic date. The frequency with which the children resisted the injection was approximately one in 20 at 69 per cent of the clinics, one in 10 at 19 per cent, and one in five at 12 per cent of the schools. A drop of blood or vaccine following an injection was encountered less than 12 per cent of the time. Six of the gun operators observed had originally been trained by the Immunization Project staff, while 10 were "second generation," having been trained by physicians originally trained by the project staff.

Another survey of the Communicable Disease Investigation personnel responsible for gun maintenance was conducted when the guns had been in use for three months. Nineteen of the 20 districts requesting guns had been using them regularly. In all but one district preventive maintenance and repair and

sterilization were carried out weekly; one district performed these efforts bi-weekly.

The most common maintenance problems in all 19 districts surveyed are listed in Table 4 in descending order of reported frequency. Subcutaneous nozzle clogging was caused by rubber "O" ring fragments or by excessive oil in the nozzle opening. Autoclave settings in many districts were too high initially; consequently, the rubber "O" rings were damaged and had to be replaced frequently until the settings were corrected. When clogged nozzles occurred in the field, they could be repaired with a fine brass wire and disinfected with acetone. Cocking levers occasionally did not function smoothly because of fragmented "O" rings around the spool valve or because of incorrect spacing of the switch spring. On occasion, the plunger kapseal was worn and did not form a tight seal in the vaccine discharge chamber.

The Communicable Disease Investigator spent an average of 2.2 hours per week performing routine maintenance on the gun. When the regular CDI was not available in the district, his substitute performed repair work satisfactorily 89 per cent of the time.

### Comment and Summary

The initial experience of the County of Los Angeles Health Department with the jet guns was, in general, most satisfactory. After the school program got under way, most health districts were using jet guns. Physicians and nurses readily accepted the gun. Favorable comments were made by volunteers of Parent-Teacher organizations at the school clinics and by school health personnel. The training of gun operators was relatively simple because of previous familiarity with the gun. However, the training of gun maintenance personnel involved more frequent and more in-

tensive sessions since they had had no previous experience with the guns.

A survey on the efficiency of jet gun operation revealed that after two months of field use, the guns were still functioning smoothly and were being used properly in most instances. The majority of physicians had been trained by other district physicians rather than by the Immunization Project staff. These physicians were using the gun efficiently and with ease. The major problem encountered was the slow rate of clinic flow. It required a new approach to clinic organization to realize the great saving in time afforded by the gun. Unnecessary delays occurred before a new classroom of children arrived at the central immunization site and the lack of children waiting with cleansed arms were the major blocks to a steady, rapidly moving line of children.

Another survey reviewed the effectiveness of the gun maintenance program after three months of field experience. Frayed rubber rings and mechanical difficulties such as improperly adjusted trigger and cocking lever springs were the most frequent problems encountered. In most districts, these problems were few and were easily handled by the local Communicable Disease Investigator.

It soon became apparent that many problems could be avoided in the field by weekly maintenance checks, by test firing the gun during a clinic when switching to a new vaccine vial, and by checking the nozzle for tightness every 20 immunizations.

For large-scale community immuniza-

**Table 4—Common maintenance problems**

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Nozzle clogged
Rubber "O" rings damaged by autoclave
Cocking lever sticky
Plunger kapseal worn

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tion programs, jet injector guns have a definite place. Savings in salaries and vaccine costs are considerable. In Los Angeles County these savings paid for the cost of the guns in the first four months of use. With adequate training of personnel, problems were not numerous initially and were rare after a few months of experience in the field. In the future, the guns will be used in Los Angeles to administer other types of immunization including smallpox vaccine.<sup>4</sup> They may also be used for tuberculin testing<sup>5,6</sup> after appropriate trials are conducted locally.

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## Road to Health Careers

The Student Health Opportunities Program (SHOP) is under way in New Jersey for the third year. Over 70 students, selected on the basis of their interest in health careers and scholastic achievement, are working on a rotating basis in various departments of 13 participating hospitals for eight summer weeks. SHOP is helping to alleviate the critical health manpower shortage while, at the same time, providing high school students with summer jobs which introduce them to the more than 250 careers available in hospitals. The program, made possible by a grant from three pharmaceutical companies, is administered by the Hospital Research and Educational Trust of New Jersey, an arm of the New Jersey Hospital Association.

SHOP encourages participating students to consider directing their education toward health careers, and the program's success in this direction has already led to the establishment of similar programs in Michigan, California, and Virginia.

(Hospital Research and Educational Trust of New Jersey, 1101 State Road, Research Park, Princeton, N. J. 08540.)